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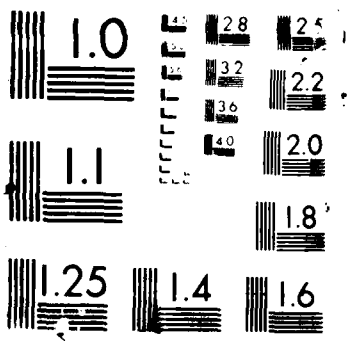
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FULDA GAP VIDEO DISC - A TACTICAL DECISION AID

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My presentation describes a video disc based system which was developed to demonstrate potential applications as a tactical decision aid. It covers the creation of the video disc containing data for the Fulda Gap area of Germany, the system for exploitation of the disc, and the potential uses of the stored data which have been demonstrated. An evaluation of results to date and future plans is included.

The Automated Cartography Branch of the U.S. Army Engineer Topographic Laboratories (USAETL) began research in the mapping applications of video disc technology in the Spring of 1982. The research objective was to find out the feasibility of using video discs for the storage, retrieval, and use of mapping products. Once the feasibility was determined, practical applications of video disc systems could then be developed. To this end, the first video disc produced, called the "Columbia River Video Disc", contained a wide variety of images. This imagery included topographic maps, aerial photo mosaics, blueprints, landsat photography and motion video.

Working with the Columbia River disc, it was possible to determine the optimum field-of-view sizes and image overlap percentages. Software development for the Fulda Gap Video Disc was begun using the Columbia River disc. By beginning the software development this early, the content and appropriate layout of the Fulda Gap Video Disc could be determined. This helped insure that when the software and Fulda Gap disc were combined, the goal of a practical and flexible decision aid would be met.

The Fulda Gap Video Disc contains a total of 41,700 frames of separate images. The order of the image groupings is: Map Legends, Topographic Maps, Aerial Photography, Factor Overlays, Ground Photography, Three-Dimensional Terrain Scenes, Organizational Diagrams and Weapons System Diagrams and Photographs.

Approximately one-half of the video disc frames are images of topographic maps. Two sets of standard topographic maps were photographed to produce images at five scales. The first set is of 1:250,000 Joint Operations Graphics (or JOGs). This set was photographed twice. The first group of images showed a 40 x 40 kilometer field-of-view; the second group showed a 20 x 20 kilometer field-of-view. The second map set used was of 1:50,000 topographic maps. This set was photographed three times. The first images showed a 10 x 10 kilometer field-of-view; the second group showed a 5 x 5 kilometer field-of-view; and the last group had a 2.5 x 2.5 kilometer field-of-view. These images were placed on

the disc starting with the largest field-of-view and ending with the smallest.

Aerial photographs were placed next. The area was photographed three times. The three scales correspond with the 10 x 10 kilometer, 5 x 5 kilometer, and 2.5 x 2.5 kilometer fields-of-view used for the 1:50,000 topographic map.

The Factor Overlays were placed next. These consisted of four different terrain analysis overlays for one 1:50,000 map sheet. The four overlays were: vegetation, Concealment from Aerial Observation in Winter, Concealment from Aerial Observation in Summer, and Cross-Country Mobility. Each overlay was photographed three times, and the fields-of-view for each scale correspond to the 10 x 10 kilometer, 5 x 5 kilometer and 2.5 x 2.5 kilometer fields-of-view for the 1:50,000 topographic map.

The next group of images was the Ground Photography, which were photographs of bridges, intersections, buildings and the countryside in W. Germany.

The next section of images was the Three-Dimensional Terrain Scenes. These scenes had been digitally generated on a DeAnza system and then photographed using a Matrix Camera. The scenes generated were for 42 observation points in the Fulda Gap area. Each observation point had eight different terrain scenes. Two elevations were selected; 1000 meters and 3 meters. For each elevation, four scenes were generated at 90-degree increments around the horizon.

The group of images following the Three-Dimensional Terrain Scenes consisted of organization charts of the Soviet Combined Arms Army.

The last group of images were photographs and diagrams of Soviet and American weapons systems. For each country, the weapons systems were grouped as follows: Tanks, Armored Personnel Carriers, Artillery and Air Defense Weaponry.

The order of image placement on the video disc, described above, was used so that different images which corresponded to each other (such as the topographic maps, aerial photography, and factor overlays) could be accessed in the minimum amount of time.

To produce the Fulda Gap Video Disc, all images were first photographed using a 35-mm camera. This 35-mm film was then transferred to a 1" Type C video tape. The video tape was then transferred to a glass disc, which was used to produce an aluminum master stamping disc. The aluminum stamper was then used to press the replicated copies of the disc. The first disc pressed is usually called a "check disc", this means that it does not have the protective covering and as a result, can be damaged by scratches or other mishaps. The purpose of the check disc is to allow viewing of the images on the disc for quality control. Once the check disc is approved, the production run of the needed replicated copies is made.

When photographing the topographic maps, the first step is to mosaic the map sheets together. In the case of the 1:250,000 JOG, only two maps sheets were involved. With the 1:50,000 scale, the resulting mosaic was approximately 12' x 6'. To ensure the chosen horizontal and vertical overlap of 75 percent was maintained throughout the filming, the map bed on which the mosaics were placed

A-1

was computerized. In some cases, the map bed is stationary and the camera movement is computer-controlled.

The aerial photographs were also mosaicked but since the photographs were at a 1:24,000 scale, numerous measurements of specific points on this mosaic had to be compared with measurements of the same points on the topographic maps so that the resulting three field-of-view sizes would correspond with the three smallest fields-of-view for the 1:50,000 topographic map.

Once the Fulda Gap Video Disc was received, it was incorporated into the video disc system. The system hardware was comprised of a laser disc player which was controlled by a Systems Group S-100 microcomputer with a color monitor and CPM 2.2 operating system. A decoder takes the National Television Standard Committee (NTSC) signal from the video disc player and converts it to a Red/Green/Blue (RGB) signal for the microcomputer. The monitor has a resolution of 512 x 480 and is equipped with a touch-panel that is comprised of horizontal and vertical infrared beams. When the infrared beams are broken, the coordinates are checked with the software program for that particular phase and the scene on the monitor is changed accordingly. The software is contained on two 5" floppy discs and different programs are loaded into the microcomputer from the dual floppy disc drive. The software is written in PILOTplus; this language was selected because of its speed and flexibility. The software controls viewing the video disc, produces graphic overlays for the monitor, and stores textual information which can be displayed on the monitor or output to a printer.

At present, the program options available are: Map Reconnaissance, USA and USSR Order of Battle, USA and USSR Weapon Data, Climate Data, Three-Dimensional Views, Aerial Photography, Situation Map:Templating, Situation Map:Keyboard, Map Overlays, Unit Type Data (Soviet), Factor Overlays, and Roads and Bridges.

The Map Reconnassiance option allows a user to first select the size of the area he wishes to view. Then, he selects a map of the area he is interested in by inputting the UTM coordinate. At this point, that particular map frame will appear on the video monitor and the user is given the option of panning about that area, zooming in for a closer look or out for a broader view of the area. Since the software is set up to zoom in and out from the centerpoint of the image, he may wish to pan about the map so that the UTM coordinate he requested is approximately centered on the screen, before doing any zooming. Since there is aerial photography which covers a portion of the same area covered by the 1:50,000 map, the user may also have the option to select an aerial image of the map which he is viewing. Should the user wish to verify a particular symbol, an option is available which allows viewing the legend frames for that map and then returning to the map image.

The next program option is USA and USSR Order of Battle. This information is contained on the floppy discs. When the program is activated, a country is first selected for the menu, then a major unit, the level of detail and finally, the method of transmittal. Once these queries have been answered, the information displayed will consist of the units' name, location, commander and percent effectiveness. Since this information is contained on the floppy discs, it can be updated as necessary.

The USA and USSR Weapon Data option provides quick access to a number of American and Soviet weapons systems. The photographs and diagrams are contained on the video disc and the text information regarding system and armament characteristics is contained on the floppy discs. Aviators, who have been introduced to the video disc system, found this option especially attractive, since access to the information was much quicker than looking it up in a book. Characteristic information includes fuel capacity, vehicle range, speed, fording and step limitations, caliber and range of armament, rounds on-board, and vehicle personnel requirements.

Climate Data is stored on the floppy discs. This information is historical and easily updated as required. Data available either on the monitor or printer, includes sunrise and sunset, monthly mean precipitation and temperatures, ground conditions, snow depths, and winds. Access to this information is important for planning purposes.

The observation points for the Three-Dimensional Terrain Scenes were located along avenues of advance in the Fulda Gap area. These scenes allow familiarization with the topography in the area as well as pinpointing blind spots. This information could be helpful when planning defensive, offensive, and hit-and-run tactics, or intercept courses. When the user selects an observation point, the image is displayed on the monitor. Information as to UTM coordinate, elevation, and viewing direction is also displayed. The user can change elevation, rotate 90-degrees or select another observation point.

The Aerial Photography allows viewing of a portion of the Fulda Gap area at three different scales. The viewer can zoom in or out and pan about the area at any of those scales. When used in conjunction with the topographic maps, these aerial photographs provided an added dimension for understanding the maps.

The next two options, Situation Map:Templating and Situation Map:Keyboard, are the same except for the method of entry. The Templating option uses the touch panel to interact with the programs. This option allows the user to place different symbology on a video background. Pre-programmed symbols denoting different units and minefields are available for the user. These symbols can be placed anywhere on the screen, moved around, or erased. Once the user is satisfied with the placement, this information can be written to a data file. When the Map Overlay option is selected, this data file can be output to a plotter, which will print a mylar overlay in the requested scale for use with paper maps. This option has been compared to using a grease pencil on acetate film, though the plotter is much faster. Another element of the Templating option allows the user to keep track of deployed columns through the use of arrows.

Organization charts of a Combined Arms Army are contained in the Unit Type Data (Soviet) option. These charts show the number of a particular type of unit which is included in a larger unit.

The Factor Overlays option concerns itself with the area east of Fulda. Only one 1:50,000 map sheet was used for this section. There are four corresponding terrain analysis overlays. These are: Vegetation, Concealment from Aerial Observation (Winter), Concealment from Aerial Observation (Summer), and

Cross-Country Mobilty. Since each overlay was photographed three times, using 10x10, 5x5 and 2.5x2.5 kilometer fields-of-view, the user is able to zoom in or out, and pan around the area. All four overlays were photographed to allow the user to switch from one overlay to another while still viewing the same area. If the user needs to check symbols, a legend for each overlay is available.

The last option, Roads and Bridges, makes use of the ground photography on the video disc. When Roads are selected, along with a video image, textual information will appear on the screen. This information includes the UTM coordinate, width, road materials and any limiting factors for off-road movement. The Bridges selection operates the same way, but the textual information differs slightly. The information for bridges includes the UTM coordinate, the overall width and travel width, type of bridge, materials, and load bearing capacity. The user may choose whether or not he wishes to see a map location; if selected, the display will switch to a map with an arrow pointing to the UTM coordinate of either the road or bridge.

Throughout 1985, the Fulda Video Disc was demonstrated to many military, government and civilian groups and individuals. Most of the demonstrations were conducted at ETL. The S-100 system, the primary briefing tool for our video disc work, was used to give the demonstrations. The system's Aydin color monitor is the only display device that we have with interactive control via the built-in touch screen. This made it possible to have some audience participation during demonstrations, something more difficult to accomplish with keyboard entry systems. Although the Aydin monitor was used effectively when the Fulda video disc was demonstrated to groups of four or five people, the small (13" diagonal) screen size became restrictive when demonstrations were given to larger groups. It was very difficult to give effective demonstrations with so many people crowded around the small screen. A larger color display was needed.

Through another ETL project, an AQUASTAR large-screen projection color CRT system was installed in the video disc demonstration room and was interfaced to the S-100 system at the Aydin monitor via RGB/Sync cables. The AQUASTAR was placed against the back wall of the room, 7' above the floor and 11.5' from the large (8'x8') projection screen. The height of the unit above the floor gave sufficient clearance for even tall observers, provided they did not stand closer than midway between projector and screen. The AQUASTAR is a three lens system that requires convergence correction for any change in projection distance. For this reason, the unit has not been moved since installation.

For demonstration purposes, the viewing area is adequate. Both the small screen Aydin monitor and the large projection screen on the wall behind it can be observed at the same time. However, there are some limitations to this set up. In order to see the image projected via the CRT unit, the room must be darkened completely. Increasing amounts of room light progressively wash out the image on the screen. Of course, with the room darkened, the hardware cannot be easily seen. This makes it particularly difficult to use the keyboard when needed without turning the lights on.

Demonstration of concept is of primary importance in our video disc work effort. That purpose can be filled with equipment not intended for formal

briefings. Overall, the large screen display is an effective briefing tool for large groups within the limitations previously discussed. Our CRT projection system works well as a display-only device. However, control of the Fulda video disc demonstration is still maintained by selecting commands via the touch panel on the Aydin monitor or through keyboard entry. The small Aydin color monitor in our S-100 system meets our day-to-day needs but is not the best size for large group demonstrations. As a suggestion to anyone planning to purchase a video-based briefing system, a 19" or 25" color monitor fitted with a touch panel unit would permit more than four or five people to view the demonstration under normal lighting. Audience participation would be possible by using the interactive screen, something not possible with a CRT projection system alone.

The system's flexibility allows its use as a operational planning tool, a briefing system, or a visual display of on-going operation status. Use of the system requires very little instruction. Selecting PILOTplus for software development allows quick modification and/or development of new options without affecting options already available. Since each user might have different priorities, customizing does not entail an inordinate amount of time or expense. Ease of programming allows for changeover in personnel with a minimum of disruption. The options developed on this system are only a few of those possible.

Development of new mapping applications of optical storage technology is contingent upon the acquisition of an advanced hardware system, continued software development, and the foundation that has been established through the work that has been done to date. Project engineers at USAETL, tasked to develop mapping applications of video disc technology, will continue to solicit input from users of tactical decision aids such as the TRADOC schools and the Combined Arms Center (CAC). Input from users of battlefield intelligence gathering systems and tactical operations planning systems will help refine the applications programs that have already been developed and will also guide the development of potentially more effective mapping applications.

The procurement of an advance hardware system will have a direct bearing on the visual sophistication of future demonstrations. Our plans call for acquiring a 16-bit microcomputer-controlled system with both magnetic and optical WORM disk drives, a video disc player accommodating either 12" or 8" platters with a two second maximum frame-to-frame search time, a color graphics monitor with a graphics adapter board, a color NTSC/RGB monitor fitted with a removable touch panel, an analog-to-digital converter, a color frame grabber, a color inkjet printer and other peripherals. With this system, we will be able to develop better display layouts and higher quality graphic designs to enhance future video disc demonstrations. We will be able to demonstrate the use of alternate data storage media (magnetic vs. optical) for large volumes of digital mapping data. The 16-bit microcomputer will provide faster response times and rapid access to that data.

Software will be acquired as part of the turnkey system. In addition to software that will control the special function boards, adapters and peripherals, there will be software that provides new flexibility in programming. As with the S-100 system, PILOTplus will be used for routine interactive program development. Included with the purchase will be a software

library that includes Pascal, C, FORTRAN, and Basic. Two operating systems, DOS and UNIX, will be available.

Applications software for two new Fulda program options will be developed this year. A semi-automated route planning program will allow the operator to "draw" a route over a background display, input parameters (i.e., vehicle data) and query the system as to total route length, point-to-point distances and travel time. Alternate routes can be planned and evaluated, as in the case of detours. Another development will be for the semi-automatic determination of forward visibility based on local relief and manmade and natural obstacles, known as line-of-sight. Azimuth, declination and field-of-view calculations will be made from existing software packages and possibly some new in-house software routines. Another ongoing effort is the development of a photo-interpretation key video disc demonstrator for terrain analysis. This demonstration of concept will show how a microcomputer-controlled video disc system can aid the terrain analyst in feature identification during the compilation stage of data base production.

The completed Fulda Gap Video Disc demonstration options reflect several years of investigation into video disc technology, mapping applications studies and an evolving concept of how best to combine computers, video hardware and mapping information to develop a tactical decision aid for the Army user. However, much work remains to be done to fully exploit this new technology. The work already done on the Fulda Gap Video Disc project will provide a strong base for expanding applications of this technology.

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